AN143

Insertion Loss and Return Loss Testing of Short Cables and Assemblies (including TOSA and cassettes)

Overview

As fiber optic infrastructure and components are designed more densely and more compactly, patch cords, cassettes, and optical subassembly cables have followed suit by becoming shorter and shorter. These short cables, which can sometimes be just 20cm in length, present certain problems for testing return loss (RL). Most RL meters, whether pulse-based or Optical Continuous Wave Reflectometer (OCWR) based, have difficulty accurately measuring the return loss of these cables. Often, the return loss from the back connector of the device under test interferes with the measurement of the front connector.

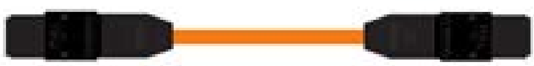

Figure 1: Short MTP®/MPO - MTP®/MPO cable

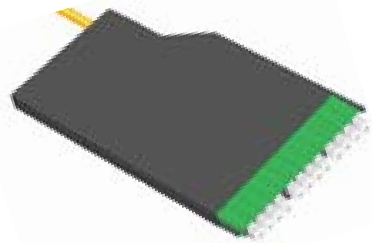

Figure 2: LC breakout cassette

Return Loss Test Method for Short DUTs

We have explored some solutions to this problem in the past (see AN-127 for more information). Here we will focus on the test method that employs a termination cable to reduce the reflection from the back connector, as this can be used for patchcords, cassettes, and harsh environment cables with plug and receptacle fixtures. We suggest this method because we believe it yields a highly efficient and repeatable measurement without sacrificing much in the way of accuracy.

This test method can be performed for either unidirectional-style tests, where the receive cable is connected to the detectors of the test system, or in bidirectional style tests, like in the diagram to the right, (figure 3) where the "receive cable" is connected to a switch that allows the light to go along the fiber path in both directions. In fact, bidirectional tests on short cable assemblies utilize this test method simply because of the required cable setup for that test.

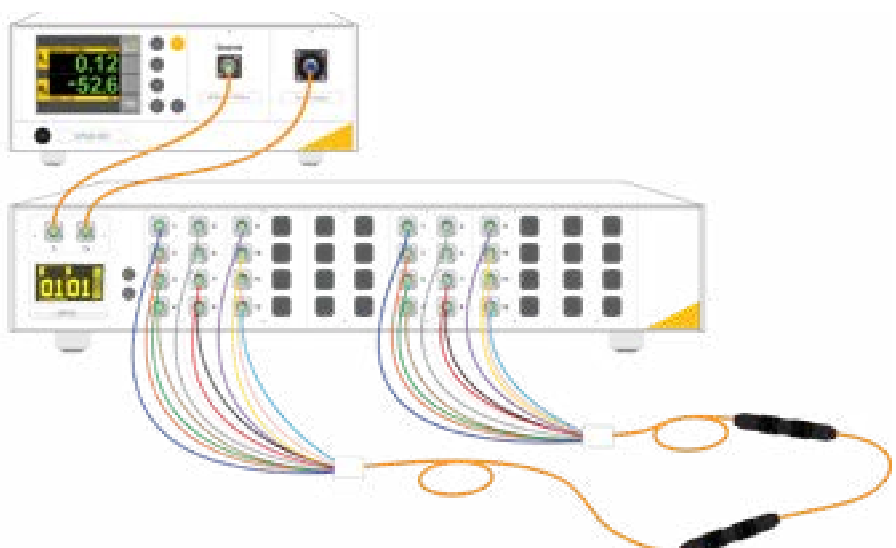

Figure 3: Testing very short cables with a bidirectional test setup gives total IL and RL for each connector.

SANTEC CORPORATION
5823 Ohkusa-Nenjozaka, Komaki,
Aichi 485-0802, Japan
+81-568-79-3536

santec
www.santec.com
The Photonics Pioneer

SANTEC USA CORPORATION
USA Toll Free +1-800-726-8321

SANTEC EUROPE LIMITED
Tel. +44-20-3176-1550

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Insertion Loss Consideration

One thing to consider with this method of testing is that the insertion loss that is measured is the sum of the IL of the two connectors and the fiber that connects them, and the RL is the combined reflectance of the two connectors. This means that the IL measurement is a “total IL” measurement and should have a corresponding pass/fail threshold. For RL, the measurement can effectively be interpreted as a “worst case scenario” measurement, where a passing value means that both connectors are better than is required.

Unterminated Short Cables

For cable assemblies where the back connector cannot be connected to a receive cable or otherwise have the reflection reduced, the test will still measure the total RL of the assembly. When measuring RL in this way, the two reflections add together according to the following formula:

$$\text{RL total} = 10 \cdot log_{10}\left(10^{\frac{RL_1}{10}} + 10^{\frac{RL_2}{10}}\right)$$

Essentially, if the two reflections are the same size, the measured reflection will increase by 3dB (e.g. 55dB to 52dB). If one reflection is much larger than the other, the return loss will be very close to the value of the larger reflection.

Therefore, if the test is measuring the combination of a UPC connection (greater than 45dB) and an open connector (as high as 15-20dB), the result will show values much closer to 15dB than 45dB.

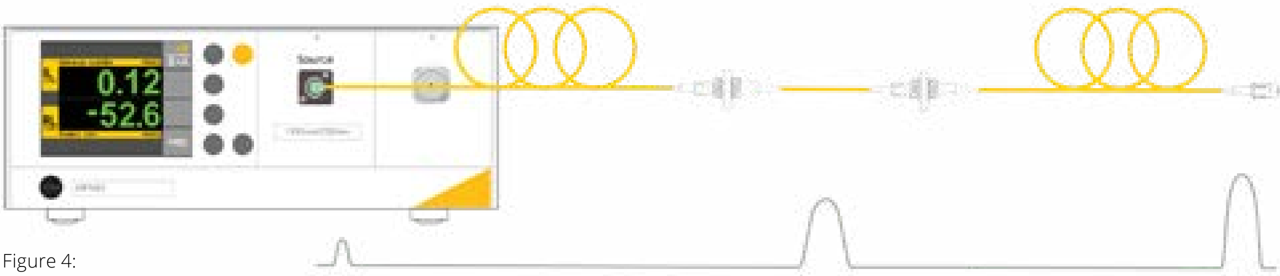

Figure 4:
With both ends of the short DUT connected to a sufficiently long reference-grade lead, the reflections of the two sides of the cable are measured as one combined reflection.

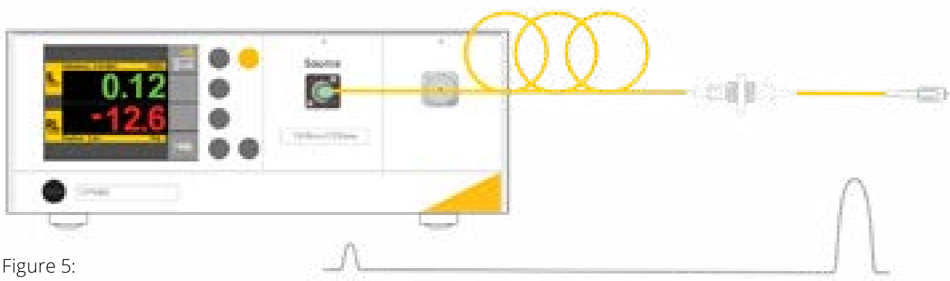

Figure 5:
With no receive cable connected to the short DUT, the reflections of the unterminated end overpowers the smaller reflection.

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